



U.S. Department of the Interior
Bureau of Land Management



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Air Resource BMPs



Best Management Practices for Fluid Minerals

Protection of Air Resources

- This slide show identifies a range of typical Best Management Practices (BMP) for protecting air resources during oil and gas development and production operations.
- **This is a partial list.** For additional Air Resource BMPs and more detailed technical and investment-payback information, please visit the websites listed in this presentation.

Using BMPs to Reduce Emissions

What types of emissions can be reduced?

- Hazardous Air Pollutants (HAPs) – Can Cause Serious Health Problems
 - Benzene, Toluene, Xylene, Formaldehyde
- Criteria Pollutants – National Standards to Protect Health and Welfare
 - PM₁₀ (Dust), PM_{2.5}, Carbon Monoxide, Sulfur dioxide, Ozone, Nitrogen Oxides
- Volatile Organic Compounds (VOCs) – Contribute to Ozone Formation
 - Propane, Butane, Pentane, Hexanes, Octanes, etc.
- Greenhouse Gases (GHGs) – Contribute to Climate Change
 - Carbon dioxide (CO₂), Methane (CH₄), Nitrous Oxide (N₂O) 3

Using BMPs to Reduce Emissions

Where Do Emissions Come From?

- Combustion Emissions: Include Criteria Pollutants, VOCs, GHGs, HAPs.
 - Come from: Vehicle Tailpipe Exhaust Emissions, Dehydrators, Mobile and Stationary Engines, Flaring
- Fugitive Emissions: Include Criteria Pollutants, VOCs, HAPs, GHGs
 - Equipment Leaks, Evaporation Ponds and Pits, Condensate Tanks, Storage Tanks, Windblown Dust (from Truck and Construction Activity)
- Vented Emissions: Include GHGs, VOCs, HAPs
 - Dehydrator Vents

Part 1

Air Resource BMPs

Transport



Reducing trucking and service traffic can reduce associated dust and tailpipe emissions.

Directional Drilling

Sixteen Wells on this Well Pad



Using directional drilling to drill multiple wells from a single well pad, rather than constructing an equal number of separate roads and well pads.

Benefits –

- Reduces road & pad construction-related dust and emissions.
- Reduces road network.
- Reduces truck traffic dust and emissions.



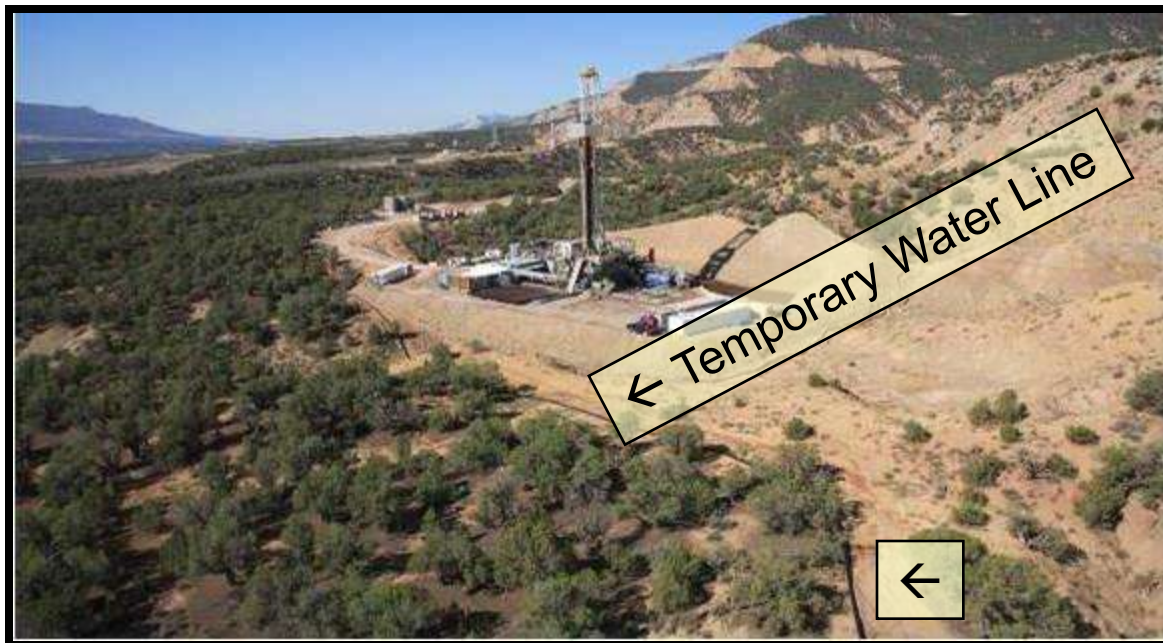
Efficiency Drilling Rig 6

Centralized Water Storage and Delivery

Using centrally stored water that is piped to the well pads and fracturing facilities through a temporary, plastic, surface line.

Benefits –

Reduces Water Hauling Truck Trips and Decreases Associated Dust and Tailpipe Emissions



Centralized Fracturing

Using centralized fracturing pads with hard-line frac pipes, some running over one mile, that can serve many well pads - representing hundreds of wells in all.

Benefits –

Reduces Water Hauling Truck Trips and Decreases Associated Dust and Tailpipe Emissions



Off Site Centralization of Production and Use of Liquids Gathering Systems

Using Liquids Gathering Systems to collect and pipe produced fluids from each remote well location to a Centralized Production and Collection Facility situated more closely to a major county or State highway.

Benefits –

Centralization creates fewer emissions sources and makes it more efficient to control emissions. Reduces Haul Truck Trips and Decreases Associated Dust and tailpipe emissions.



Telemetry & Well Automation

Using telemetry to remotely monitor & control production.

Benefits –

Reduces Service Truck Traffic
and Decreases Associated Dust
and Tailpipe Emissions



Fugitive Dust Control

Reducing Fugitive Dust From Vehicle Traffic



Dust affects air quality and creates a health and visibility safety hazard for drivers.



Dust Control

Suppression vs. Prevention

Water →

- Low Initial Cost
- Recurring Hourly Maintenance
- Increased Vehicle Emissions
- Lasts Hours



← Chip-Seal or Asphalt

- High or Very High Initial Cost
- Lasts Several or Many Years
- More Cost-effective for Roads with Higher Average Daily Traffic

Dust Control

Dust Suppressants →

Such as:

Magnesium Chloride,
Calcium Chloride, Lignin
Sulfonate, Asphalt Emulsion

- Moderate Initial Cost
- Lasts About 1 Year
- Good For Low Traffic Roads

Check with local authorities
regarding allowable use.



Dust Control - Example

Dust Suppressant –
good reduction in dust

Dust trail still
visible where
there was no
treatment



Dust Reduction

Using Reduced Vehicle Speeds to Decrease Fugitive Dust on Roads with High Traffic and High Dust Potential.



Vanpooling

Using vans and buses to shuttle employees to the worksite, thereby reducing the number of vehicle trips

Benefits –

Reduced tailpipe emissions and dust.



Part 2

Air Resource BMPs

Drilling Phase



Cleaner Diesel Power

Moving toward
cleaner
diesel engines,
Tier 2 → 3 → 4

(Tier 4 is cleaner
than Tier 2.)

Tier 4 diesel engine
standards are being
phased in from
2011 through 2014
by manufacturers of
new engines.



A Tier 2 diesel engine powers an
electric motor to drill this well.

Natural Gas Power

Natural gas powered engines are typically cleaner than diesel engines and are the approximate equivalent of Tier 4 diesel engines.



Natural gas fueled engines power electric motors to drill this well.



Venting

- Releases methane, a greenhouse gas (GHG) that has 25 times more global warming potential than CO₂

Intergovernmental Panel on Climate Change

http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_Ch02.pdf page 212

- Emits Volatile Organic Compounds (VOCs) which contribute to ozone formation
- Emits Hazardous Air Pollutants (HAPs) such as Benzene, Toluene, and Xylene in larger quantities than flaring
- Wastes valuable natural gas resources



Flaring

- Reduces Methane GHG emissions, however...
- Combustion emissions include NO_x, CO, VOCs, and PM_{2.5}, which can pose visibility and health problems, and CO₂ (a less potent GHG). NO_x and VOCs contribute to ozone formation.
- Wastes valuable natural gas resources



Flaring natural gas is usually a better alternative than venting gas; however, potential fire hazards, impacts to visibility, and citizen concerns may preclude the use of flaring at certain sites.

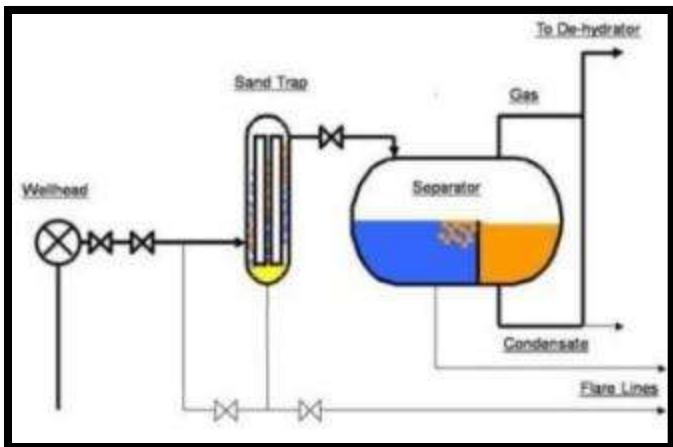
Well Completions – Reduced Emissions Completions

A Best Management Practice

Using “**Green Completions**” where there is an existing sales line to recapture a significant portion of product that would have been vented or flared.

Benefits –

- Reduces Methane & VOC emissions
- Recovers product for sale



More information at www.epa.gov/gasstar/documents/greencompletions.pdf

Part 3

Air Resource BMPs

Production Phase



Solar Power



Using chemical pumps and well monitoring telemetry powered by solar panels.

Benefits –

Reduces truck trips, engine emissions, and methane emissions from gas pneumatic pumps.

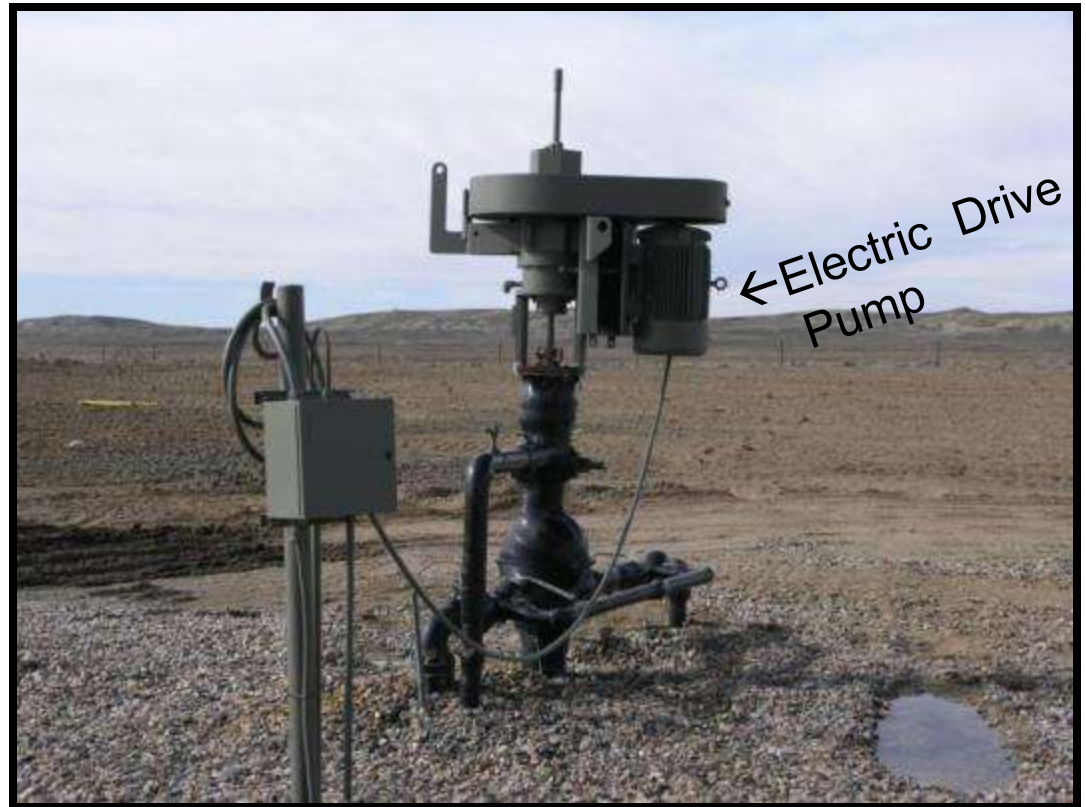


More information at www.epa.gov/gasstar/documents/workshops/2008-tech-transfer/midland6.ppt#288,1, Solar Power Applications for Methane Emission Mitigation

Electrical Power

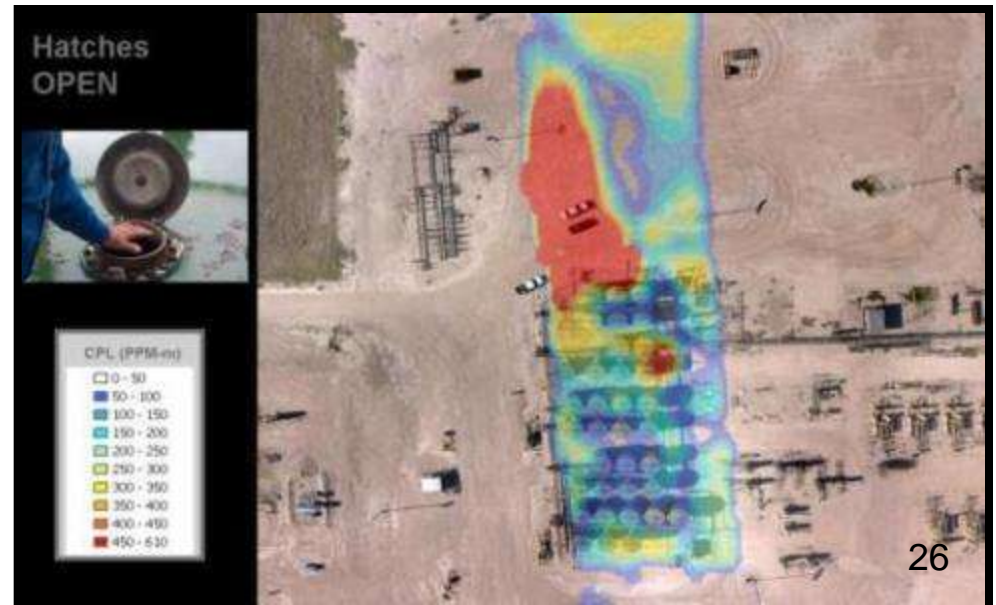
Using electricity from the nation's power grid is typically cleaner than using onsite diesel or natural gas engines to power drill rigs, compressors, and pumping units.

However, overhead power lines may have wildlife or visual impacts.



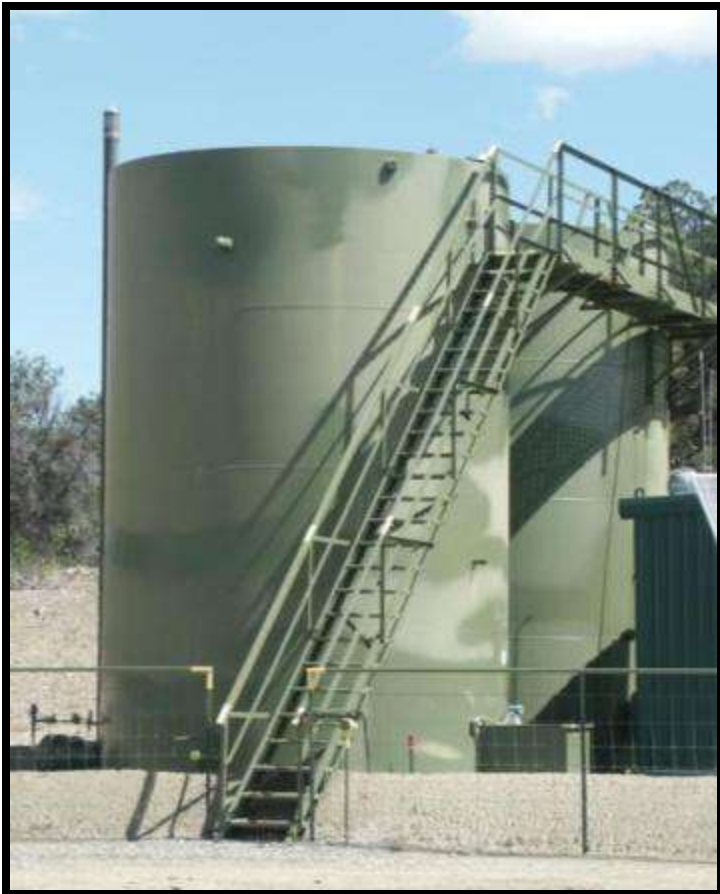
Fugitive (Leaking) Emissions

- Releases methane, a greenhouse gas (GHG) that has 25 times more global warming potential than CO₂
- Can emit Volatile Organic Compounds (VOCs) which contribute to ozone formation
- Can emit Hazardous Air Pollutants (HAPs) such as Benzene, Toluene, and Xylene
- Wastes valuable natural gas resources



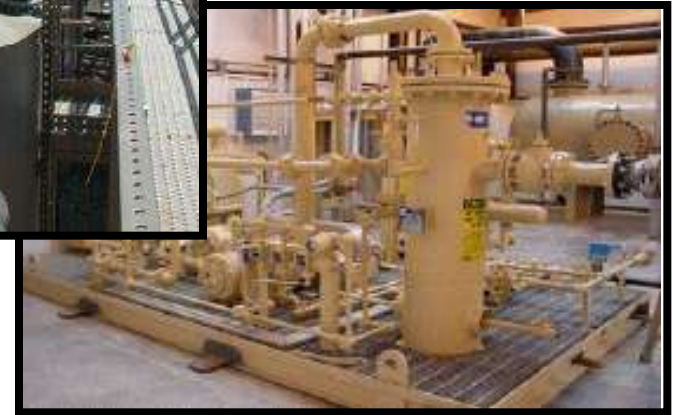
Capturing VOCs

Using enclosed tanks instead of open pits to reduce fugitive VOC emissions.



Vapor Recovery Units

Using vapor recovery units on oil, condensate, and produced water storage tanks reduces fugitive VOCs and recovers BTU-rich vapors for sale or use on site.



Vapor Recovery Economics

- Vapor recovery can capture up to 95% of hydrocarbon vapors from tanks
- Recovered vapors are more valuable than natural gas and have multiple uses. The table below illustrates several possible scenarios of peak capacity for VRU sizing

Financial Analysis for a Conventional VRU Project						
Peak Capacity (Mcf/day)	Installation & Capital Costs ¹ (\$)	O&M Costs (\$/year)	Value of Gas ² (\$/year)	Annual Savings (\$)	Simple Payback (months)	Internal Rate of Return
25	\$35,738	\$7,367	\$77,106	\$69,739	10	121%
50	\$46,073	\$8,419	\$154,213	\$145,794	6	204%
100	\$55,524	\$10,103	\$308,425	\$298,322	4	352%
200	\$74,425	\$11,787	\$616,850	\$605,063	3	537%
500	\$103,959	\$16,839	\$1,542,125	\$1,525,286	2	974%
1 – Unit cost plus estimated installation of 75% of unit cost 2 – \$16.90 x ½ peak capacity x 365, Assumed price includes Btu enriched gas (1.289 MMBtu/Mcf)						

Hatches, Seals, and Valves

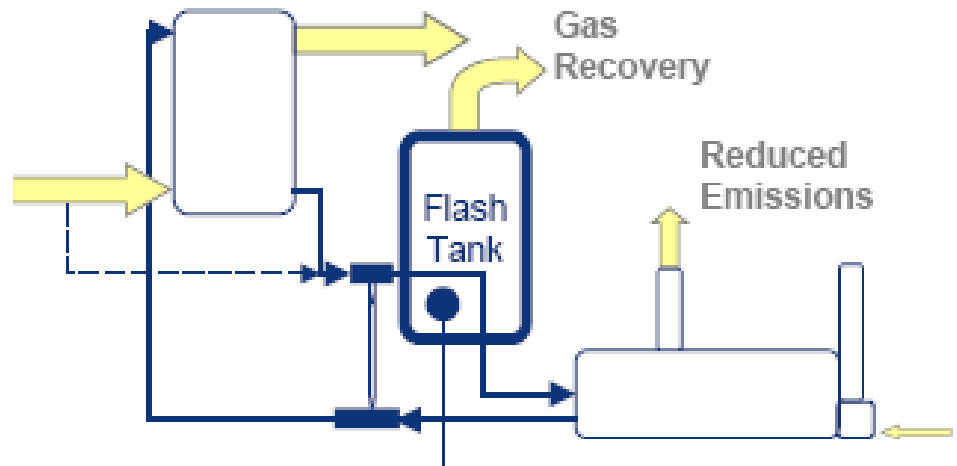
Using and maintaining proper hatches, seals, and valves to minimize VOC emissions.

Thief
Hatches and
Vent sealing
valves



Optimize Glycol Circulation and Install Flash Tank Separator (FTS)

Methane emissions that result from glycol over-circulation in glycol dehydrators can be reduced by optimizing the circulation rate. Methane that flashes from rich glycol in an energy exchange pump can be captured and recycled using an FTS.



Economics of Installing FTS and Optimizing Glycol Circulation

- FTS recovers about 90% of methane emissions
- FTS reduces VOCs by 10 to 90%

Two Options for Minimizing Glycol Dehydrator Emissions

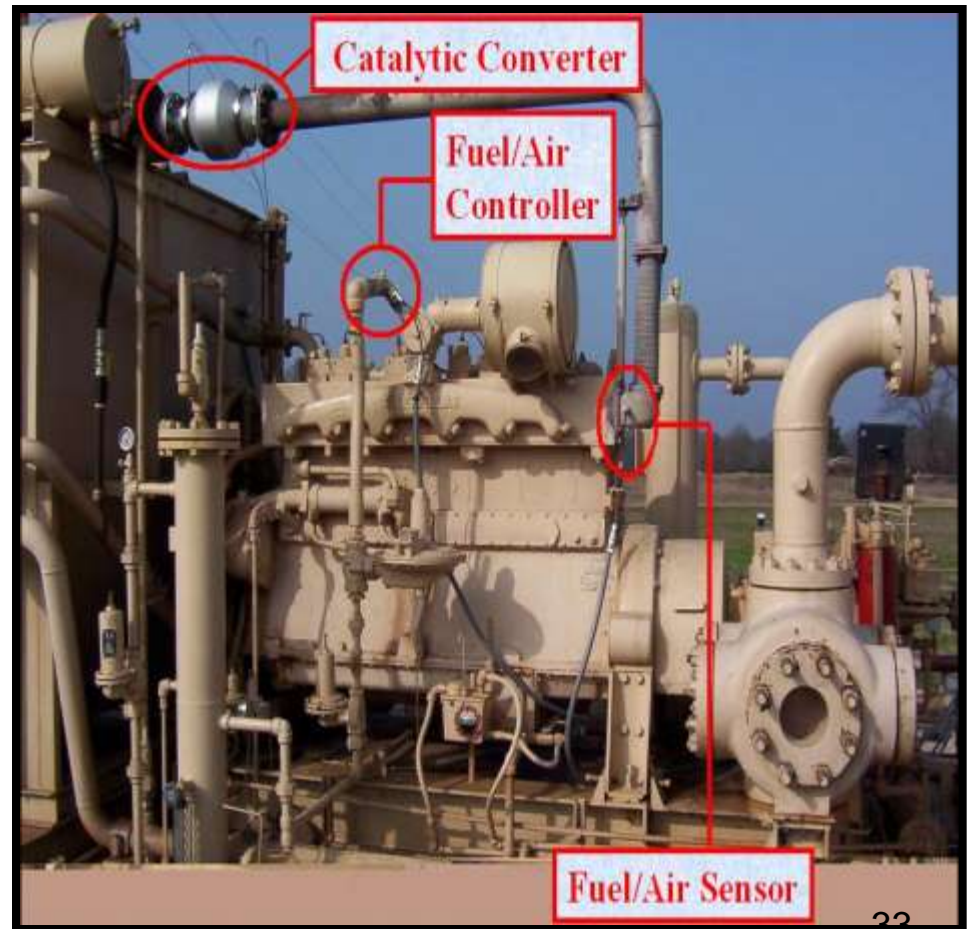
Option	Capital Costs	Annual O&M Costs	Emissions Savings	Payback Period ¹
Optimize Circulation Rate	Negligible	Negligible	394 to 39,420 Mcf/year	Immediate
Install Flash Tank	\$6,500 to \$18,800	Negligible	710 to 10,643 Mcf/year	4 to 11 months

1 – Gas price of \$7/Mcf

NO_x, SO_x, CO, and CO₂ Controls for Compressor Engines

Using....

- Closed Loop Engine Control
- Controlled Engines
- Selective Catalytic Reduction
- System-Installed Power Supply (solar powered, battery powered)
- Ultra-Low Sulfur Diesel



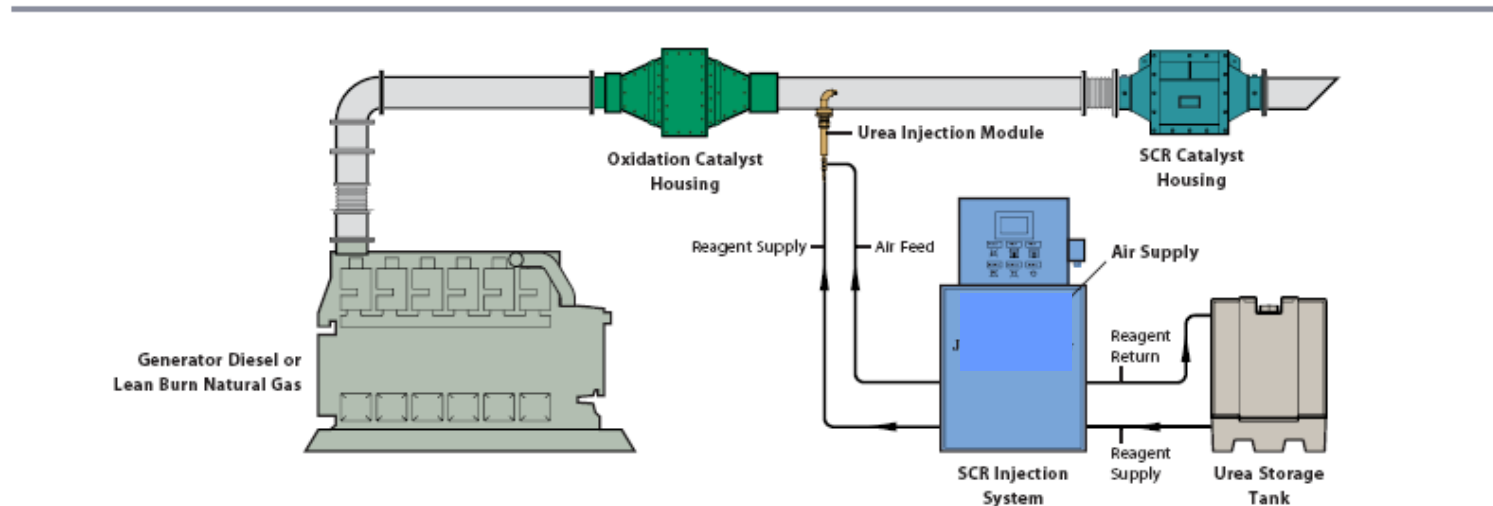
Selective Catalytic Reduction

Selective Catalytic Reduction works by injecting Diesel Exhaust Fluid (DEF) (water & urea) into exhaust. The DEF works with the heat of the exhaust and a catalytic converter to convert the NO_x into nitrogen and water vapor.



An installed SCR system.

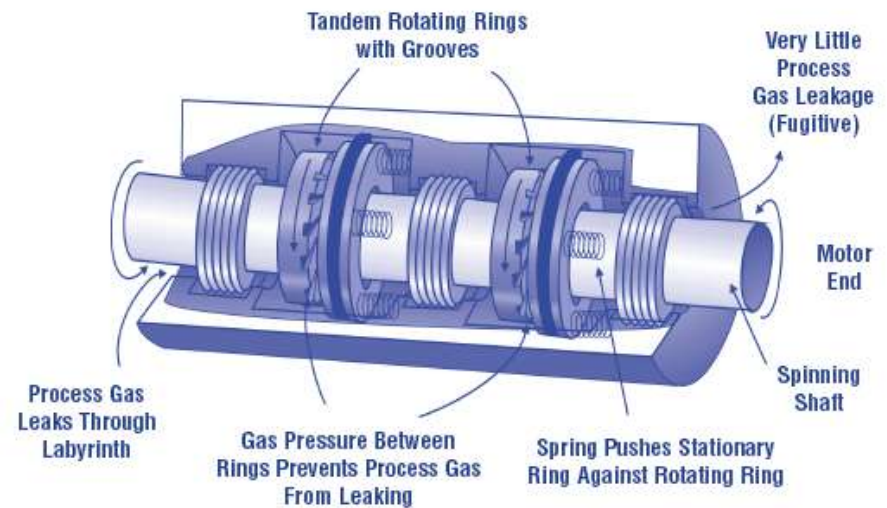
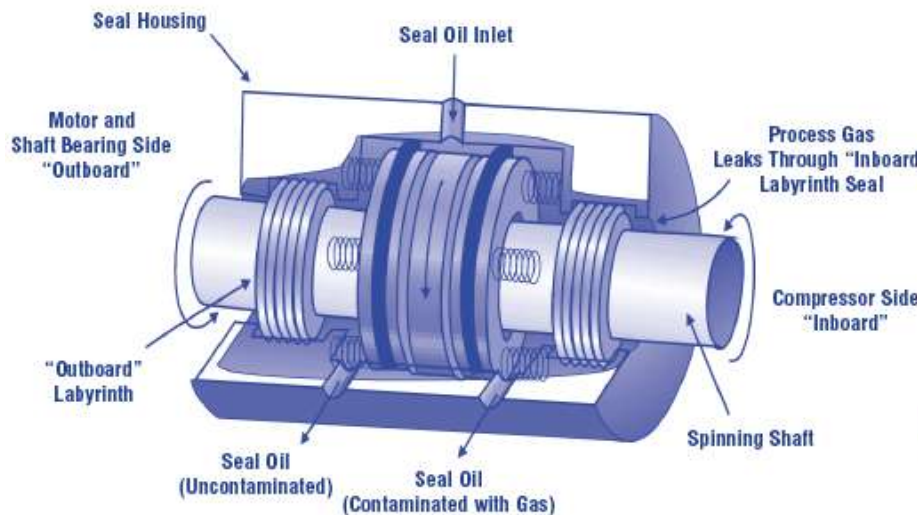
Typical Oxidation Catalyst and SCR System Flow Diagram



Maximum NO_x Control for Stationary Diesel and Gas Engines

Replacement of Wet Seals with Dry Seals in Centrifugal Compressors

Centrifugal wet seal compressor emissions from the seal oil degassing vent can be reduced by the replacement of wet seals with dry seals that emit less methane and have lower power requirements.



Economics of Wet Seal Replacement

Economics for 6 inch shaft beam compressor

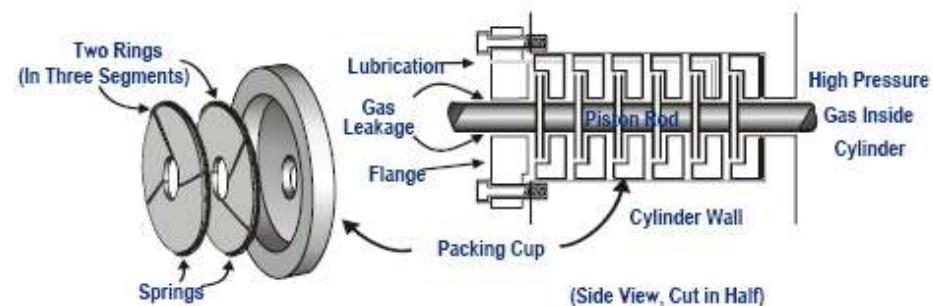
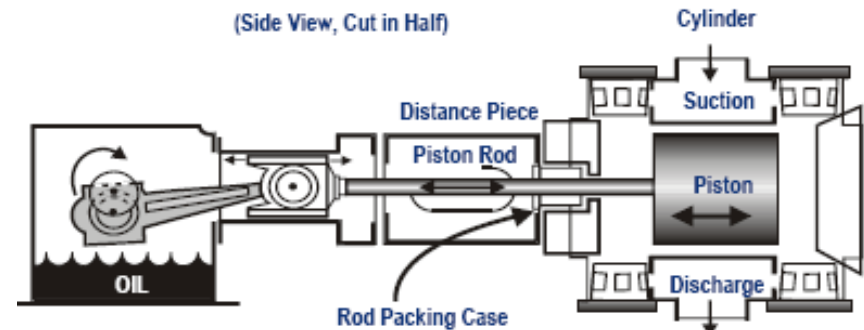
Cost Category	Dry Seal (\$)	Wet Seal (\$)
Implementation Costs¹		
Seal costs (2 dry @ \$10,000/shaft-inch, w/testing)	\$120,000	
Seal costs (2 wet @ \$5,000/shaft-inch)		\$60,000
Other costs (engineering, equipment installation)	\$120,000	\$0
Total Implementation Costs	\$240,000	\$60,000
Annual O&M	\$10,000	\$73,000
Annual Methane Emissions (@ \$7/Mcf; 8,000 hr/yr)		
2 dry seals at a total of 6 scfm	\$20,160	
2 wet seals at a total of 100 scfm		\$336,000
Total Costs Over 5-Year Period	\$390,800	\$2,105,000
Total Dry Seal Savings Over 5 Years		
Savings	\$1,714,200	
Methane Emissions Reductions (Mcf; at 45,120 Mcf/yr)	225,600	

Reduce Emissions from Compressor Rod Packing Systems

Reciprocating compressor rod packing leaks some gas by design.

Emissions from rod packing can be reduced by the economic replacement of rod packing at frequent intervals as...

- Newly installed packing may leak 60 cubic feet/hr¹
- Worn packing has been reported to leak up to 900 cubic feet/hour¹



More Information at www.epa.gov/gasstar/documents/II_rodpack.pdf

Economics of Rod Packing Replacement

Replace packing when expected leak reduction will pay back cost

- “leak reduction expected” is the difference between current leak rate and leak rate with new rings

Rings Only

Rings: \$1,620
Rod: \$0
Gas: \$7/Mcf
Operating: 8,000 hours/year

Leak Reduction Expected (cf/hour)	Payback (year)
32	1
17	2
12	3
9	4

Rod and Rings

Rings: \$1,620
Rod: \$9,450
Gas: \$7/Mcf
Operating: 8,000 hours/year

Leak Reduction Expected (cf/hour)	Payback (year)
217	1
114	2
79	3
62	4

Based on 10% interest rate
Mcf = thousand cubic feet

Pneumatic Devices for Emissions Control

As part of normal operations, pneumatic devices release natural gas into the atmosphere (liquid level controllers, pressure regulators, and valve controllers)



For Methane and VOC Reduction:

- Replace high-bleed devices with low-bleed
- Retrofit bleed reduction kits on high-bleed devices

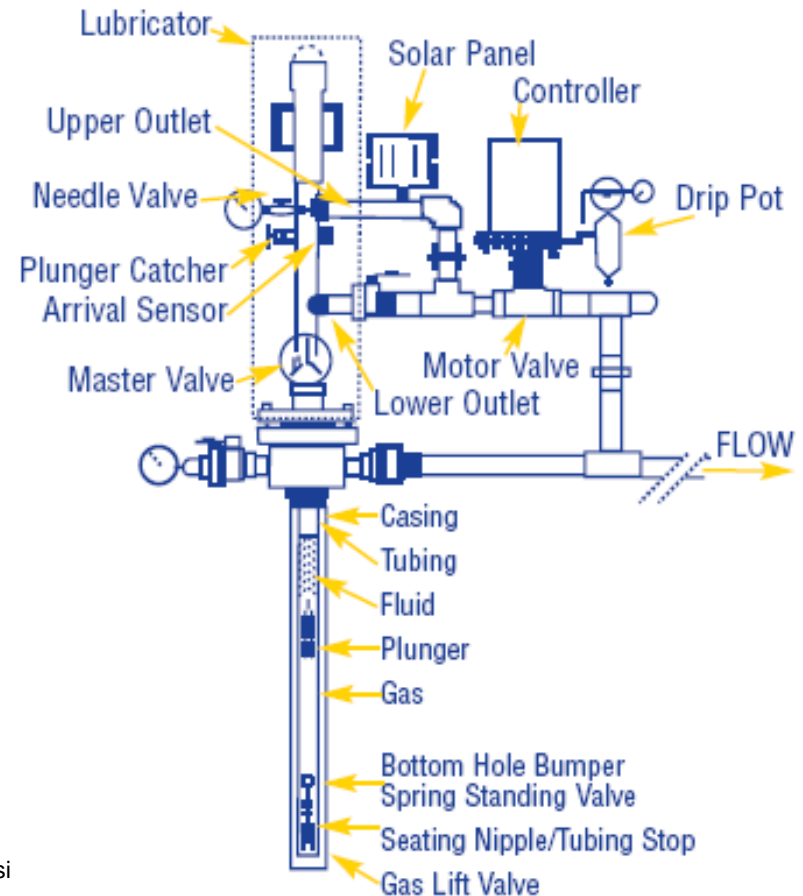


Installing Plunger Lift Systems and Automated Systems in Gas Wells

Methane emissions from well blowdowns can be reduced by installing plunger lifts and smart automation systems which monitor well production parameters.



Source: Etopsi



More info at www.epa.gov/gasstar/documents/II_plungerlift.pdf
www.epa.gov/gasstar/documents/smart_automation.pdf

EPA Natural Gas STAR Partner Experience

– BP Example

- Pilot installations and testing in 2000
 - Installed plunger lifts with automated control systems on ~2,200 wells
 - ~US\$15,000 per well Remote Terminal Unit (RTU) installment cost
 - US\$50,000 -US\$750,000 host system installment cost
- Achieved roughly **50% reduction** in venting from 2000 to 2004
- In mid 2006, “smarter” automation was applied to wells
 - 1,412 Mcf reported annual savings per well
 - Total of **US\$6,2 million/year savings**
- Emissions reduced from **4.0+ bcf/yr** down to less than **0.8 bcf/yr**

Part 4

Air Resource BMPs

Monitoring & Maintenance



Directed Inspection & Maintenance and Infrared Leak Detection (DI&M)

Fugitive gas leaks can be reduced by implementing a DI&M Program which identifies and cost effectively fixes fugitive gas leaks using

- Leak Detection
 - Infrared Camera
 - Organic Vapor Analyzer
 - Soap Solution
 - Ultrasonic Leak Detectors
- Measurement
 - Calibrated Bagging
 - Rotameters
 - High Volume Sampler



More information can be found at

www.epa.gov/gasstar/documents/03_dim_in_gas_production_facilities.pdf

EPA Natural Gas STAR Partner Experience

– Chevron Corp.

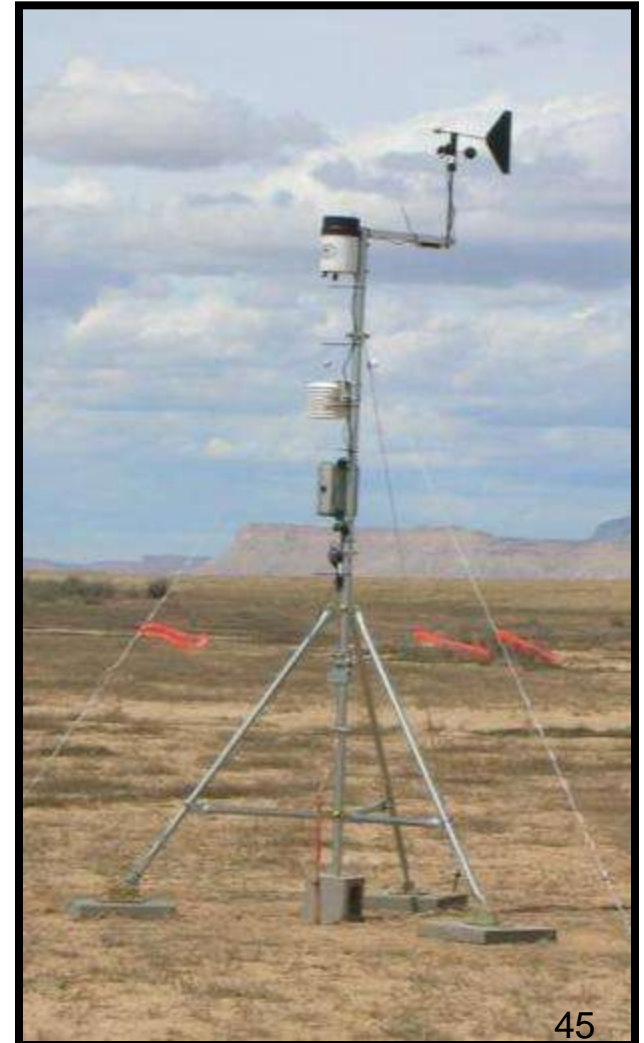
- Scanned gas facility using GasfindIR™ Camera
 - 112 total leaks recorded (60 from gas plants)
- Quantified leaks using Hi-Flow Sampler®
- Estimated leak volume:
100,000 Mcf/yr
- Estimated annual revenue lost due to natural gas, propane and condensate losses:
\$2.1 million



Air Quality Monitoring

Using Monitoring for...

1. Monitoring current and modeling future air quality conditions.
2. Designing emission control strategies.
3. Reviewing monitoring data and adapting to findings:
 - Adjusting development rates, timing, and places of development.
 - Refining mitigation measures (BMPs).



Part 5

For More Information & BMPs

EPA Natural Gas STAR Program

<http://www.epa.gov/gasstar/tools/recommended.html>

California Air Resources Board's Clearinghouse

<http://www.arb.ca.gov/cc/non-co2-clearinghouse/non-co2-clearinghouse.htm>

Four Corners Air Quality Group

<http://www.nmenv.state.nm.us/aqb/4C/>